Cerenkov Calibration

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UCL
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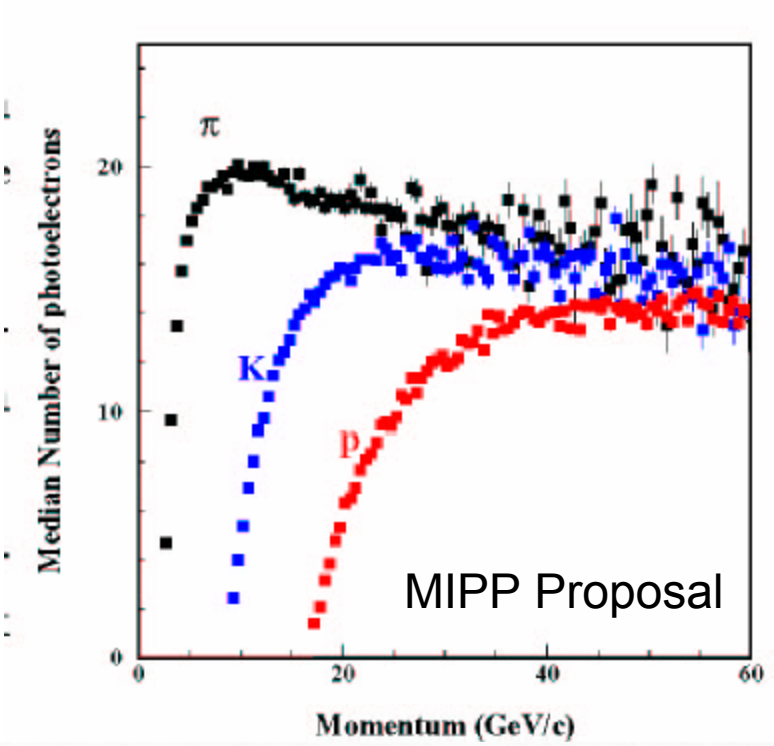
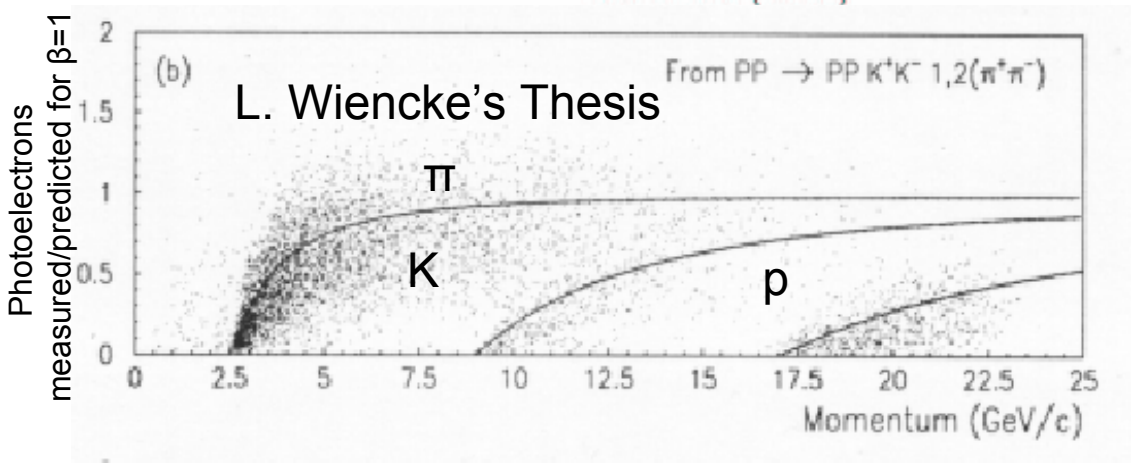
PID with Ckov

- Particle identification achieved by looking at light produced as a function of momentum
- Must Calibrate 96 PMT+mirrors!



Particle	Threshold
π	2.7 GeV
K	9.4 GeV
p	17.9 GeV

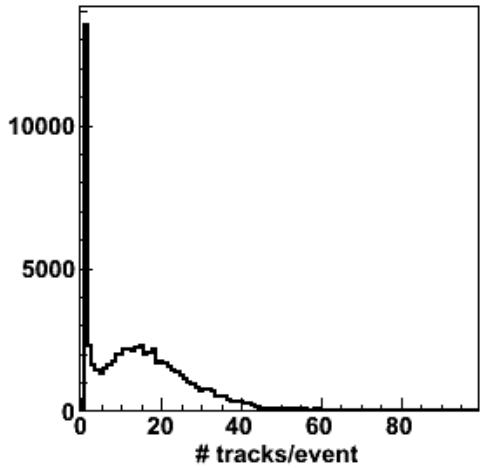


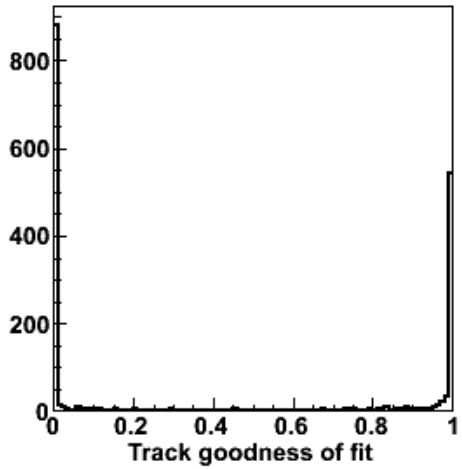
Calibration

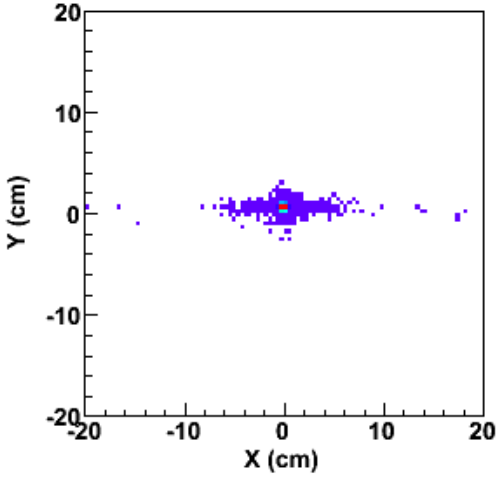
- My plan of attack:
  - At high momenta, all particles should produce the same amount of light/distance traveled through cerenkov gas
  - Determine fraction of light (F) that should hit each mirror for light cone from a $\beta=1$ particle
  - Make histograms of ADC/(FxL) for each mirror for tracks with high momenta
  - Determine constants to equalize the means of these histograms
  - Start with empty target, 120 GeV data to get lots of high energy tracks

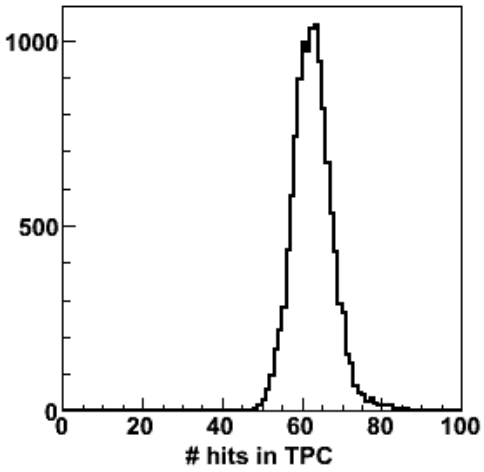
Cuts

- Select well reconstructed tracts
- Select events with low multiplicity to avoid track pileup in a mirror
- Best strategy:
  - Select events with 1 track
  - Select tracks with goodness of fit>0.01
  - Select tracks with r<1 at target position
  - Select tracks with >0 tpc hits (all single track events meet this criterion)

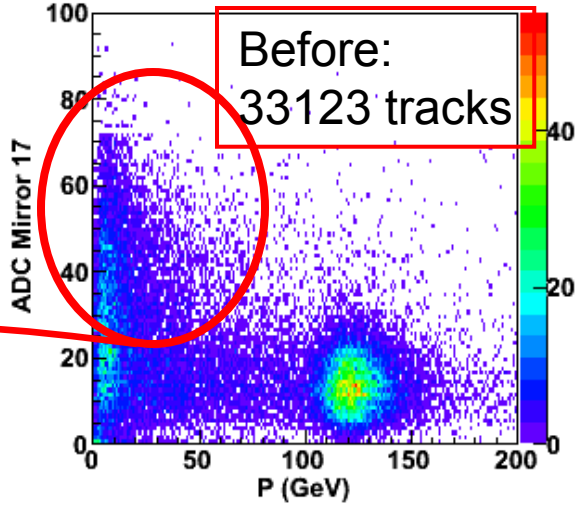


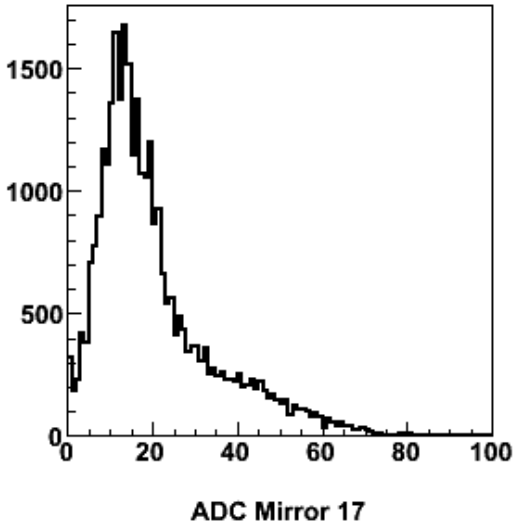




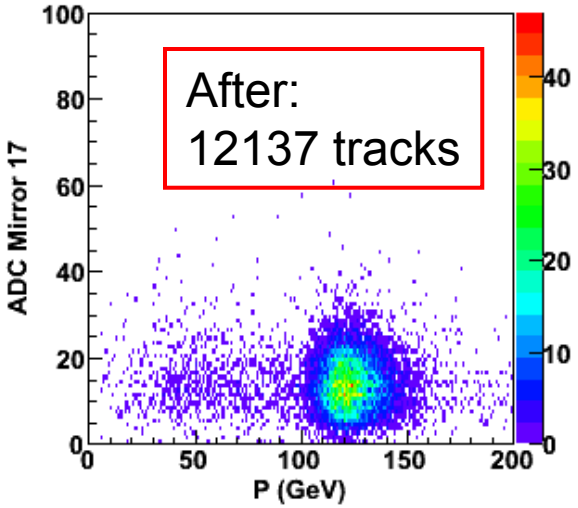


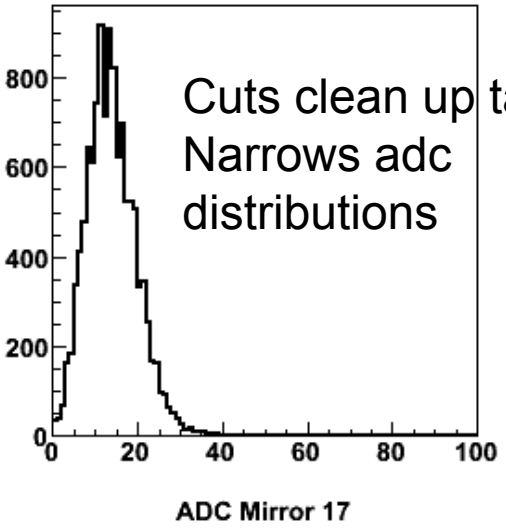
Effect of Cuts





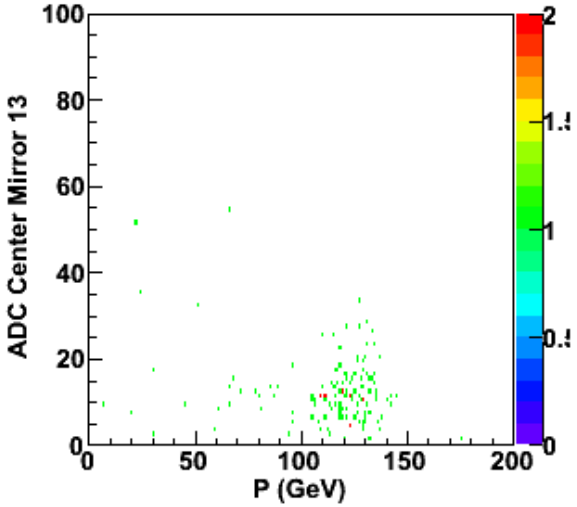
Low P, high ADC hits due mostly to track pileup

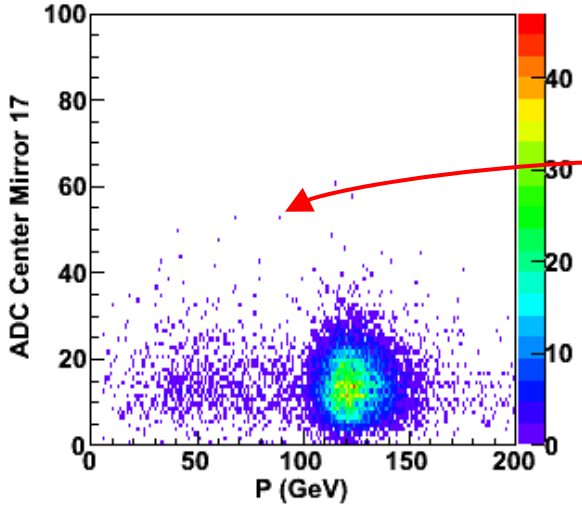




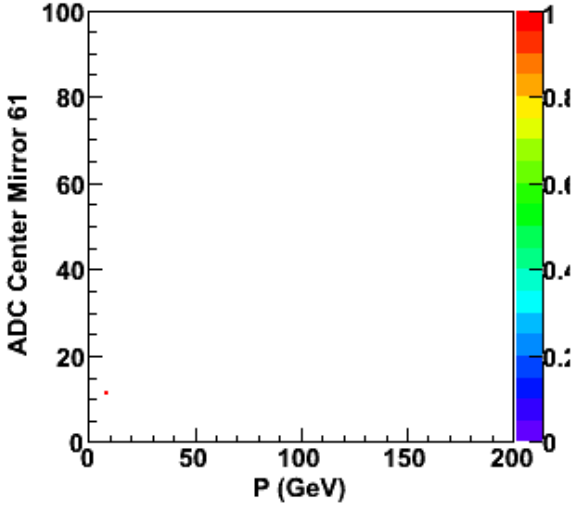
Cuts clean up tails, Narrows adc distributions

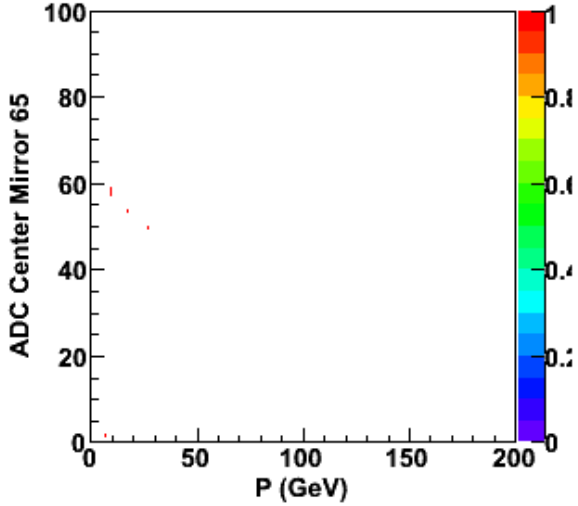
ADC vs. P for Central Mirror



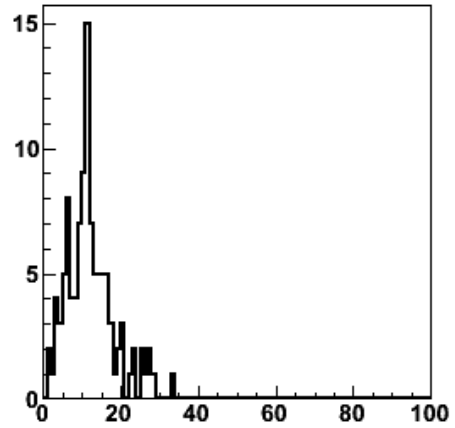


Empty Target Runs
Tracks mostly go through mirror 17

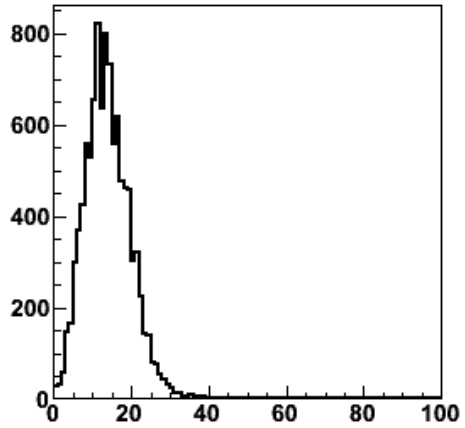




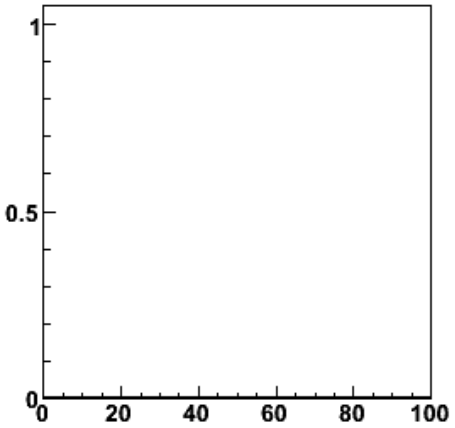
ADC for 100<p<150



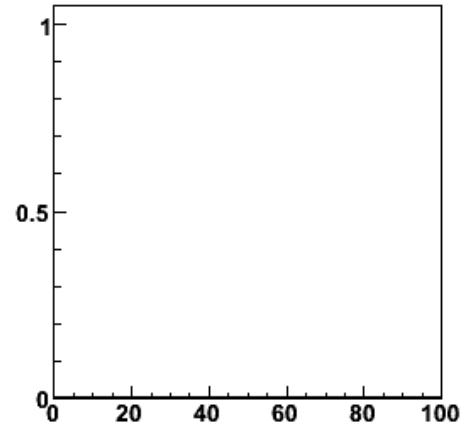
ADC Center Mirror 13



ADC Center Mirror 17



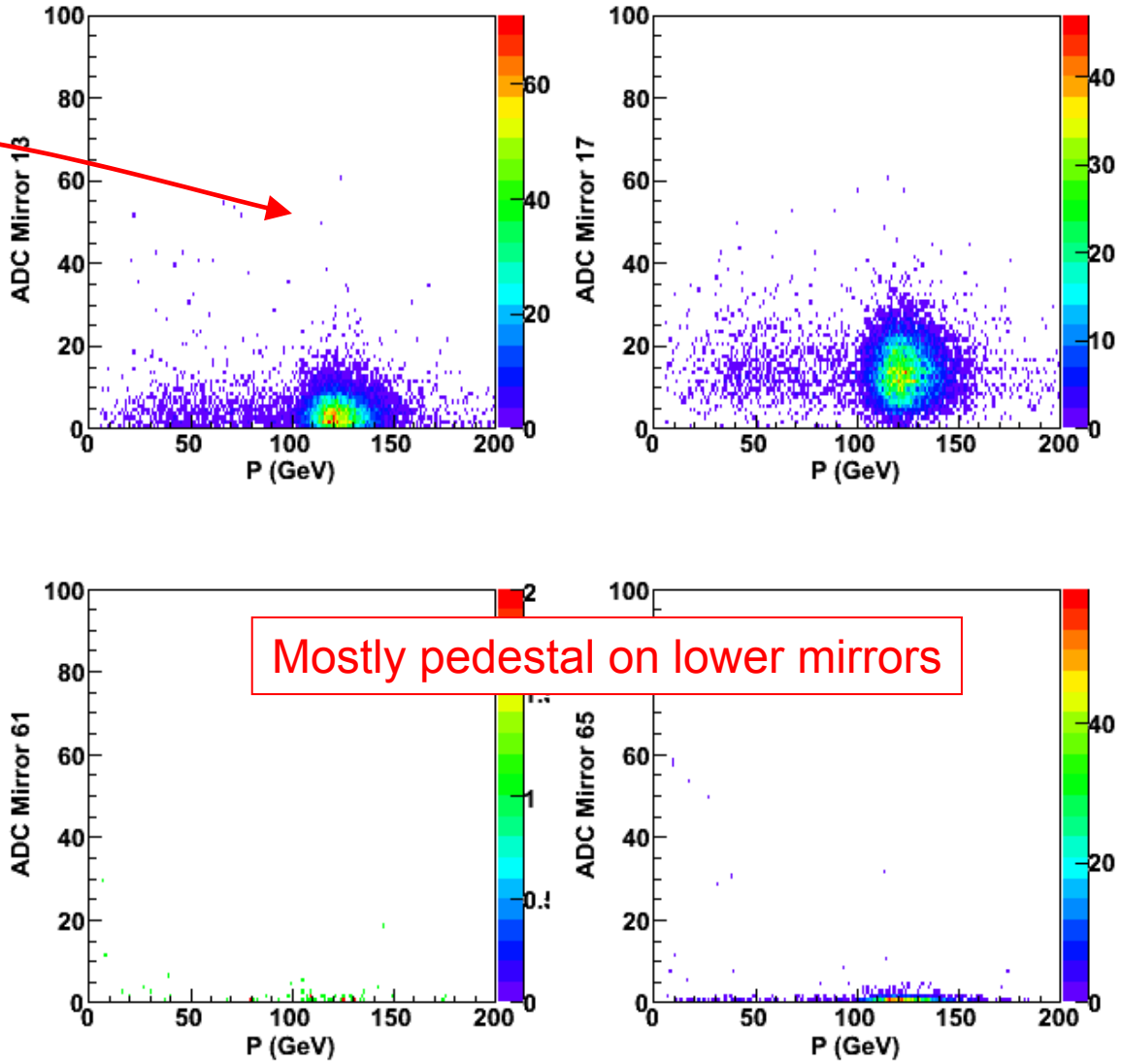
ADC Center Mirror 61



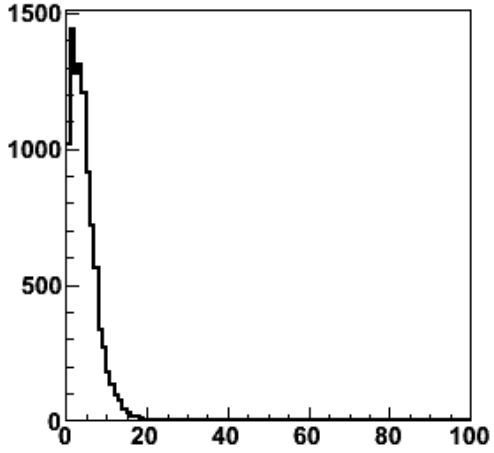
ADC Center Mirror 65

ADC vs P

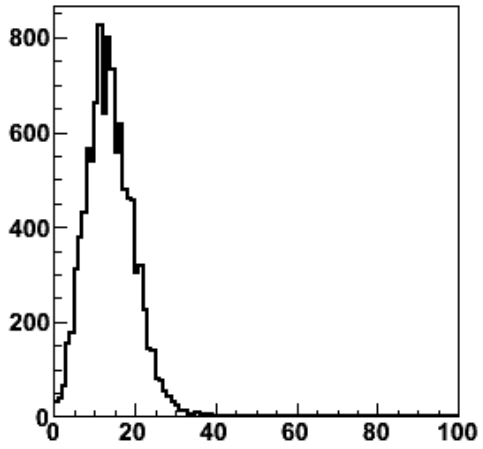
Some fraction of light spills onto mirror 13



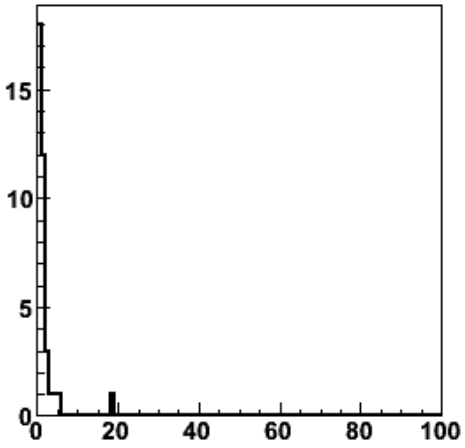
ADC for 100<P<150



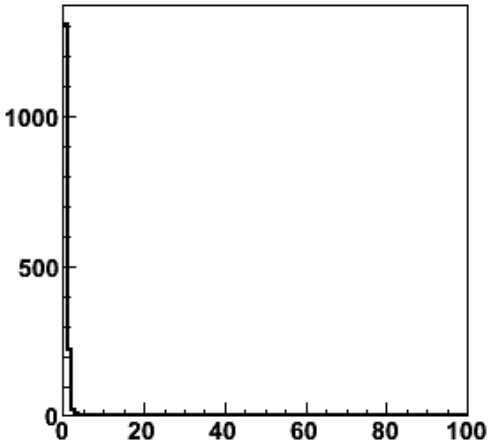
ADC Mirror 13



ADC Mirror 17

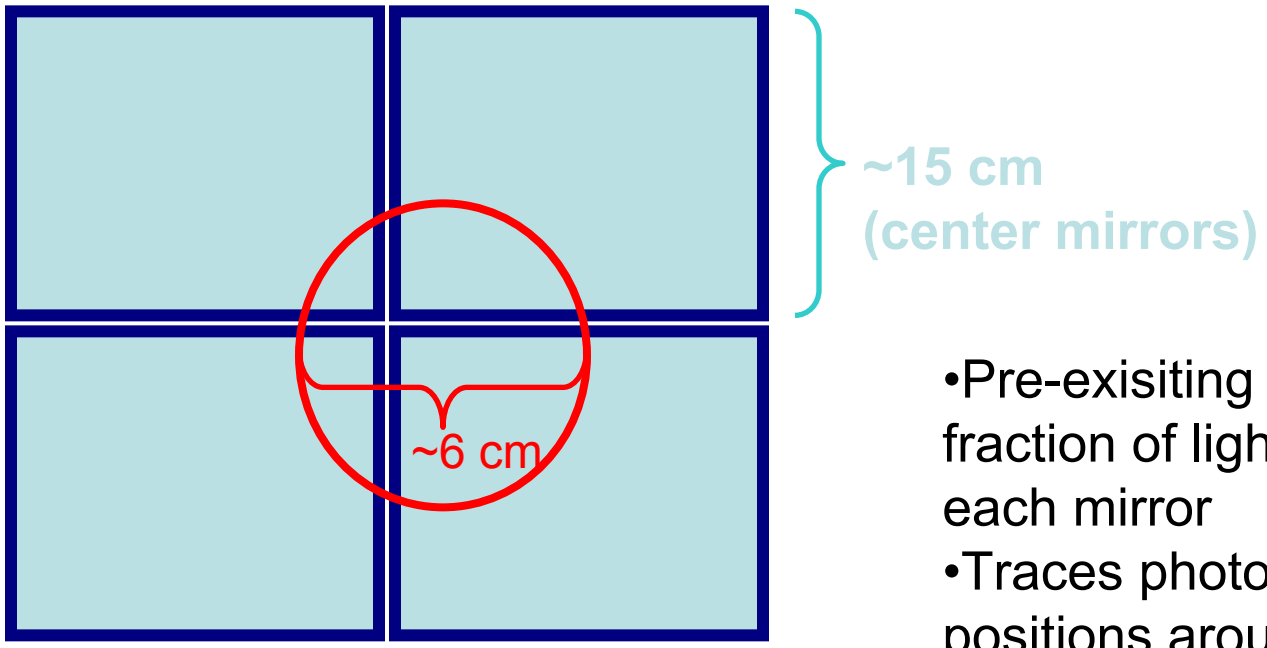


ADC Mirror 61



ADC Mirror 65

Mirror Light Fract. Correction (F)



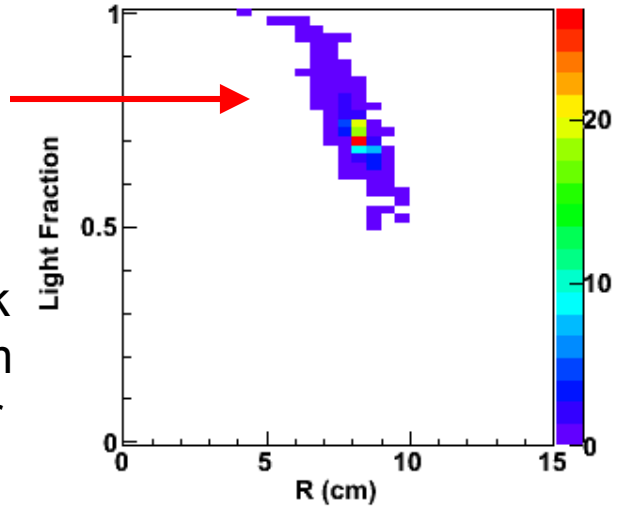
(not to scale)

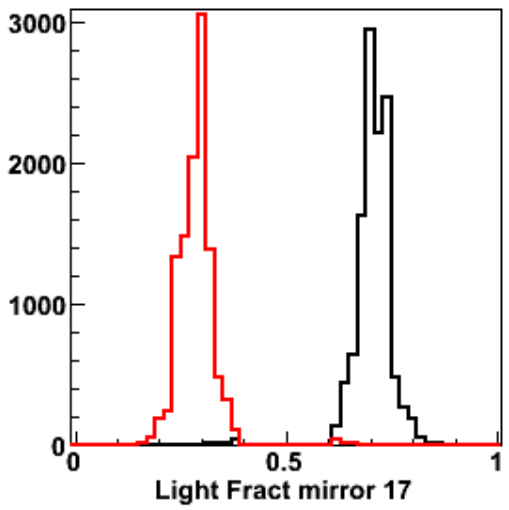
- Pre-exisiting code calculates fraction of light expected to hit each mirror
- Traces photons emitted at 160 positions around the particle trajectory and tabulates which mirror that photon hits
- Want to calibrate the quantity:
  - ADC/(L*F)

  for each mirror

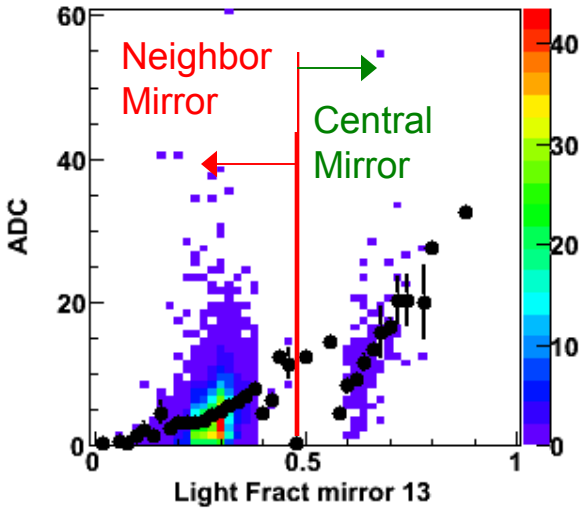
Validating F

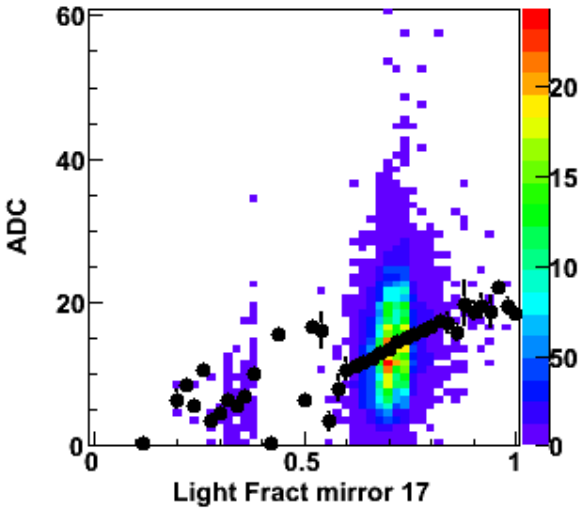
- Tracks mostly go through mirror 17 off center
- Expected F falls off as track hits further from center of mirror





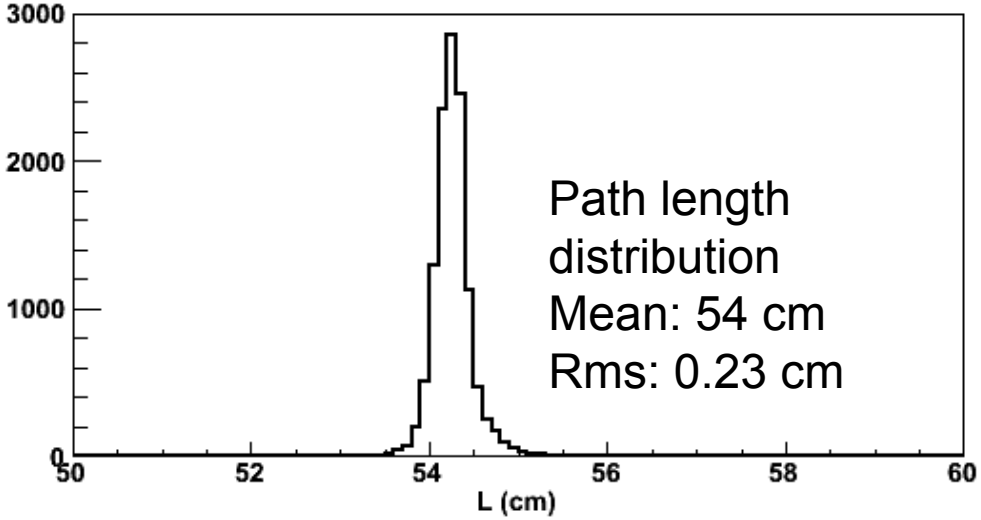
Black-F, mirror 17
Red-F, mirror 13





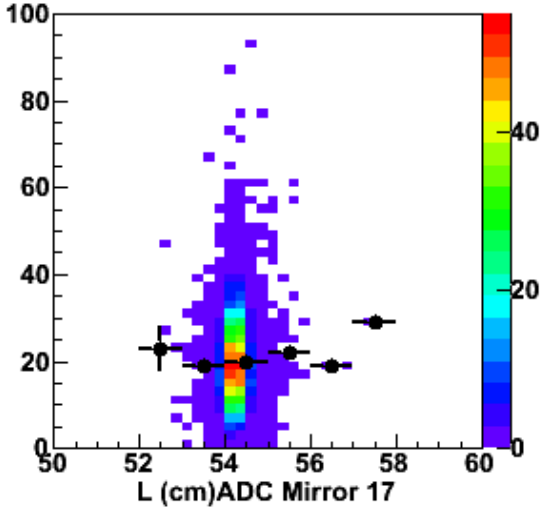
Measured ADC increases as expected F increases

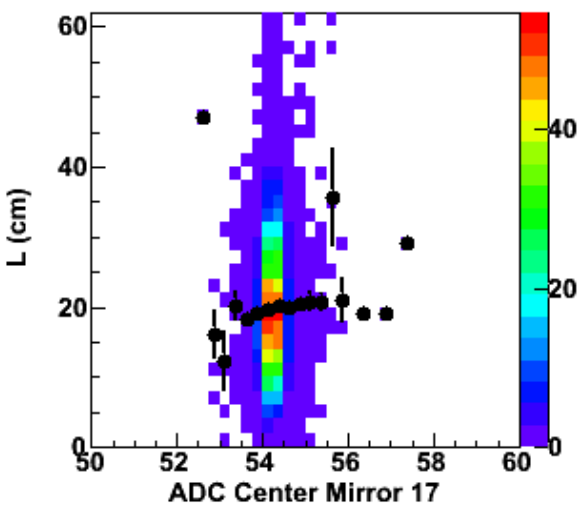
Path Length



Path length distribution
Mean: 54 cm
Rms: 0.23 cm

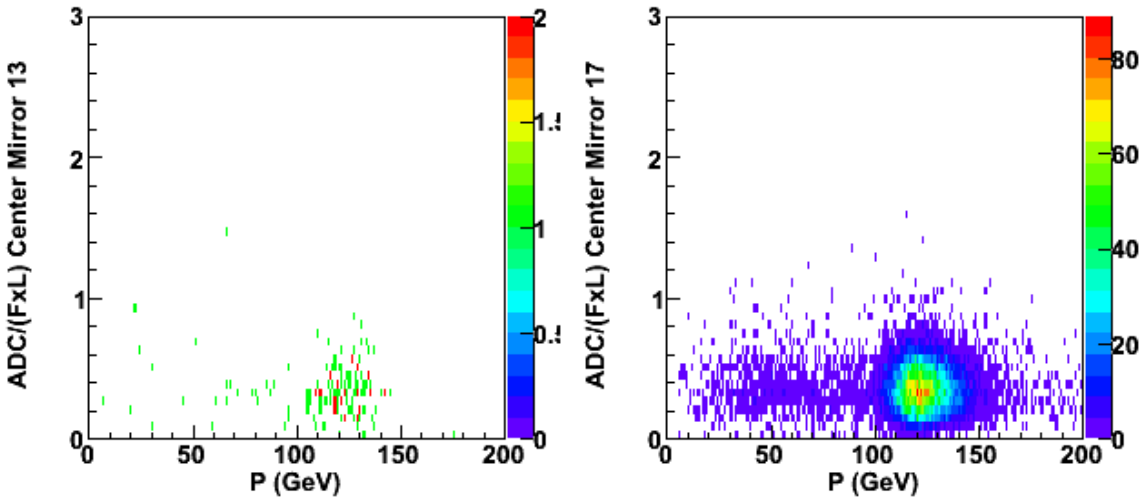
ADC/F vs. path length



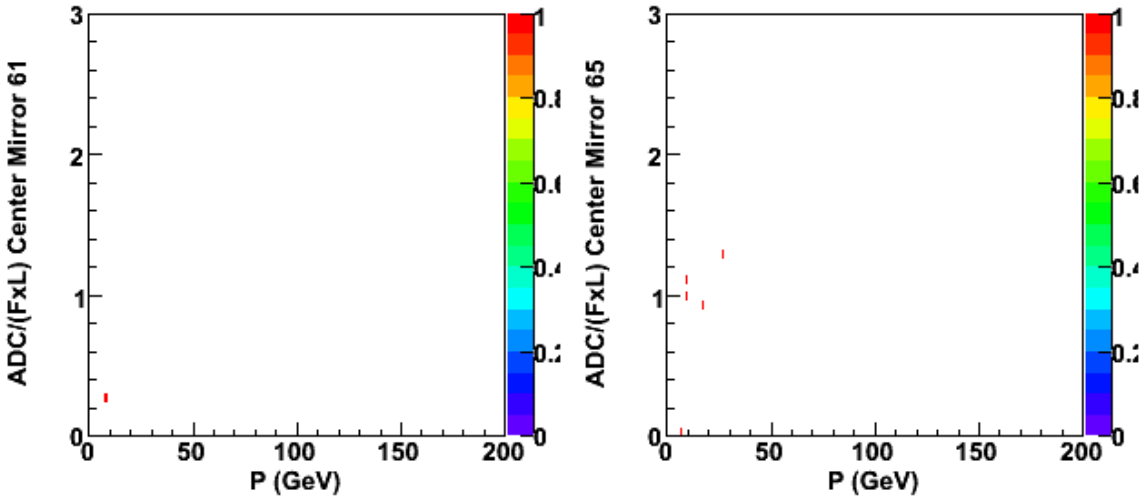


Slight dependence of ADC on path length

Calibration Histograms



ADC/(FXL) vs. P for tracks that go though each mirror

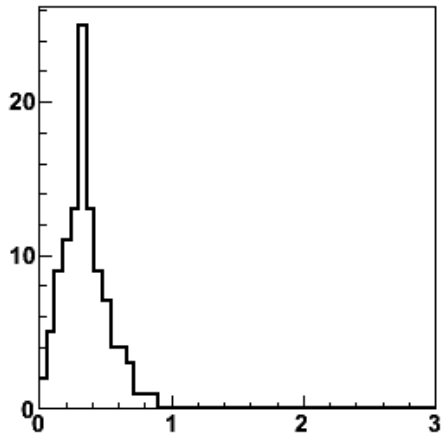


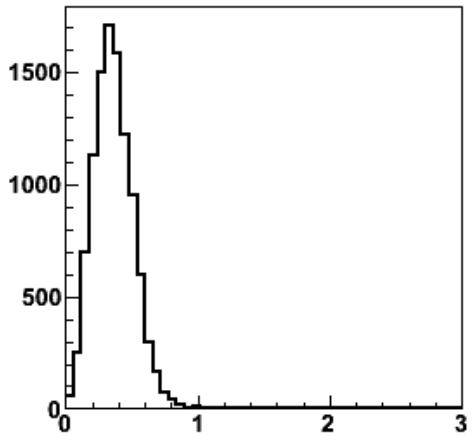
Calibration histograms for 100<p<150

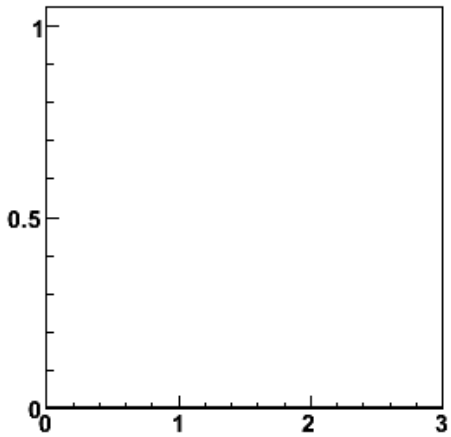
NPE~$(\mu/\sigma)^2$

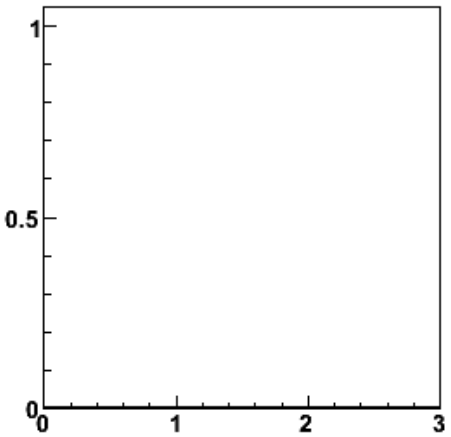
Mirror	μ	σ	NPE
13	0.351	0.166	4.47
17	0.365	0.150	5.93

Low light levels in central mirrors worrisome?



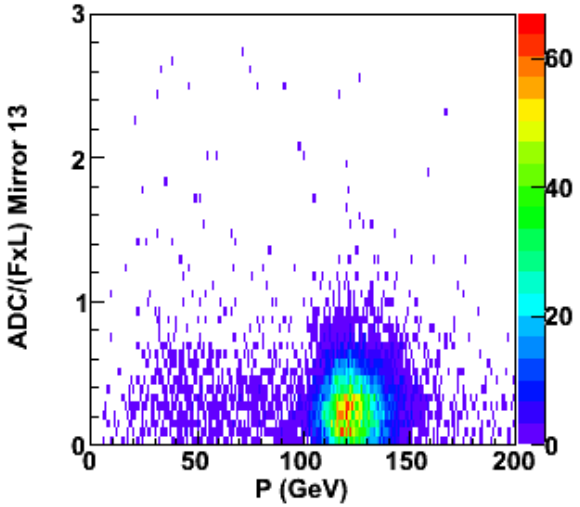


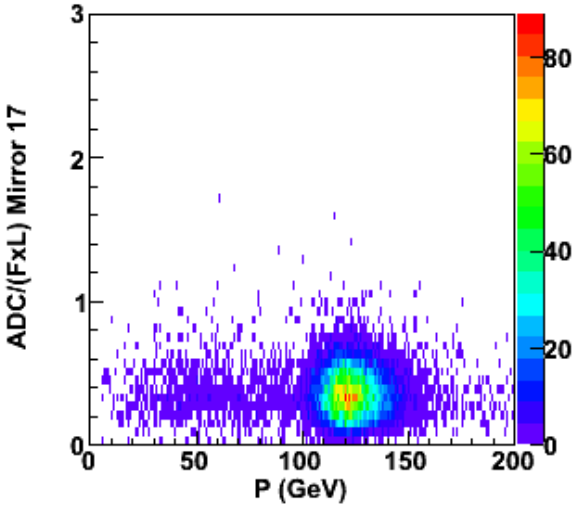




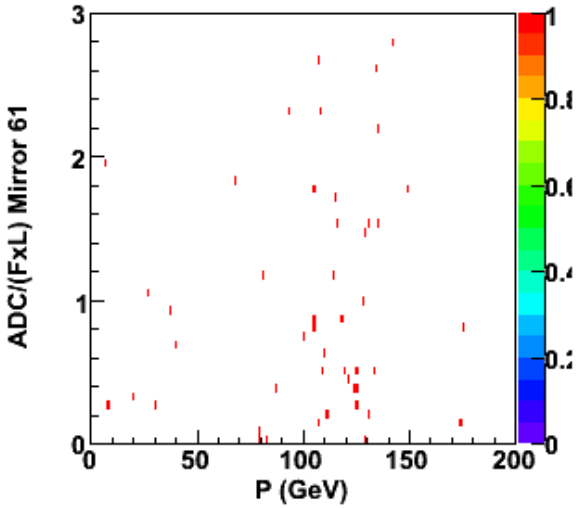
Calibration Hist vs. P

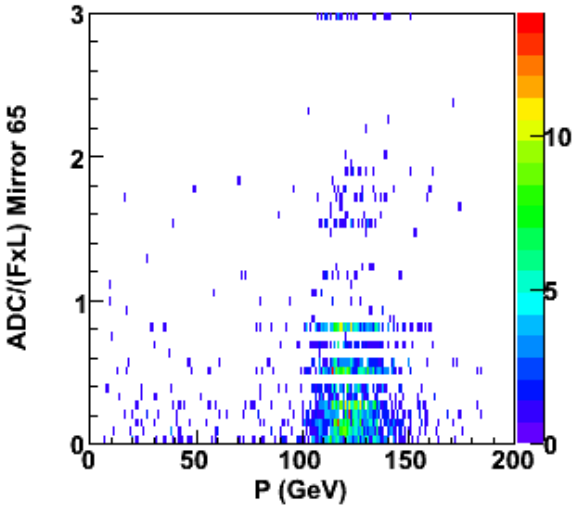
More entries available if we use neighbor mirrors





Low ADC/small F gives big values of ADC/(F*L) for mirrors that don't see much light

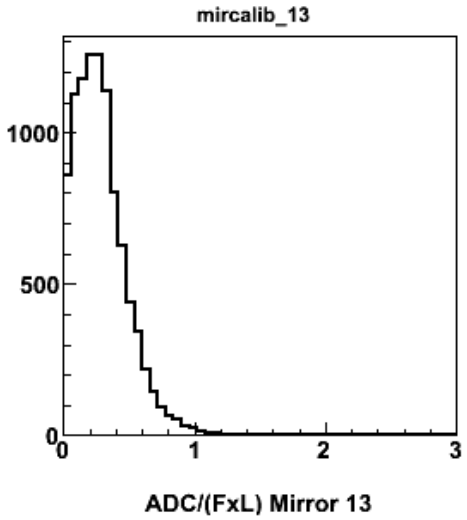


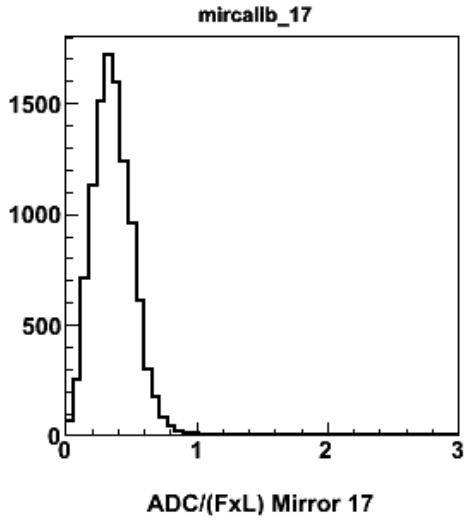


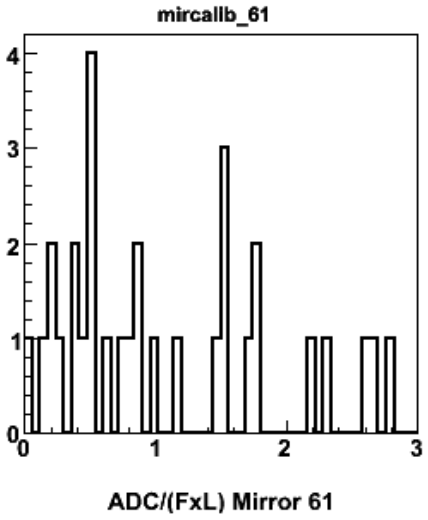
Calibration Histograms

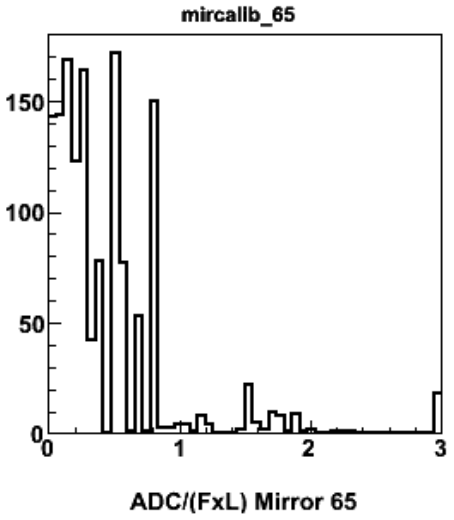
$NPE \sim (\mu/\sigma)^2$

Mirror	μ	σ	NPE
13	0.290	0.200	2.10
17	0.365	0.151	5.85



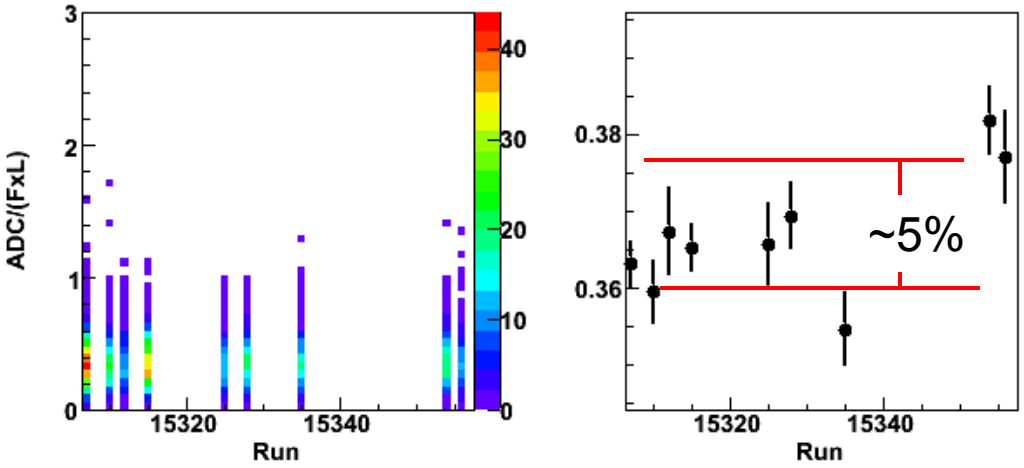


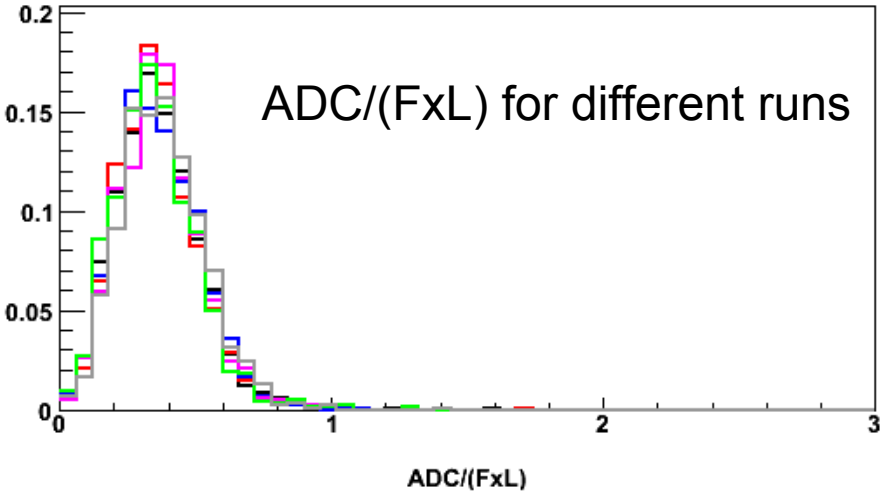




Calibration vs. Run

- Used 9 runs for previous distributions
  - Early August
  - Span 4 days
- Calibrate out environmental changes?
  - Temperature
  - Pressure
  - PMT HV





Summary

- Working on calibration mirrors+PMTs of DKov
- Have necessary quantities in hand
- Concerned about low light levels
- Need to process much more data
  - Will learn how to use FNAL user batch farm
- Next step, look at response vs. pressure, temperature, etc. . .